SALINITY TOLERANCE AND OSMOREGULATION OF THE NEW ZEALAND PEA CRAB, *PINNOTHERES NOVAEZELANDIAE* FILHOL, 1886 (BRACHYURA: PINNOTHERIDAE)

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ABSTRACT

The survival and osmoregulatory ability of ovigerous female *Pinnotheres novaezelandiae* Filhol 1886 were examined over a range of salinities at 15°C. Crabs exhibited 100% survival in 21.00 and 35.00‰, approximately 80% survival in 14.00‰, and less than 5% survival in 8.75, 5.25 and 1.75‰. Pea crabs functioned as weak hyperosmotic regulators in salinities between 11.20 and 35.00‰. Infestation of mussels by *P. novaezelandiae* was reduced under estuarine conditions compared with marine conditions. Results from the present study on adult pea crabs suggest that salinity is not involved in setting infestation rates.

KEYWORDS: *Pinnotheres novaezelandiae,* physiology, salinity tolerance, osmoregulation, estuarine habitat, pea crab, Redcliffs New Zealand.

INTRODUCTION

Many crustaceans are able to withstand the often wide salinity fluctuations typical of estuarine habitats by exhibiting

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broad salinity tolerances and osmoregulation. These adaptations have been well documented in general (Kinne, 1971; Dorgelo, 1976, 1981), however, information for pea crabs (Brachyura: Pinnotheridae) is limited. For example, Read (cited in Kruczynski, 1973) noted that *Pinnotheres maculatus* was a weak regulator and survived well in 20 and 30‰ at 25°C.

The New Zealand pea crab *Pinnotheres novaezelandiae* Filhol 1886 is a common parasite of the green lipped mussel *Perna canaliculus* (Gmelin). Crabs occupy the mussel mantle cavity and feed on the food cord collected by the bivalve host (Jones, 1977 a,b; Hickman, 1978). Baxter (1981) found that infestation rates of *P. novaezelandiae* in mussels from Redcliffs, Avon-Heathcote Estuary (43°33'S, 172°44'E) were significantly lower than at Camp Bay, a marine inlet in Lyttelton Harbour (43°38'08"S, 172°46'40"E) (G-test, $p<0.001$). The present study investigated the survival and osmoregulatory ability of *P. novaezelandiae* exposed to a range of salinities to assess whether the effects of salinity on adult survival are responsible for differences in infestation rates between marine and estuarine habitats.

METHODS

The salinity tolerance of marine ovigerous females, collected from Camp Bay, Lyttelton Harbour on 19 February 1981, was examined by subjecting crabs (mean carapace width = 10.47 mm, S.D. = 1.27 mm) to salinities of 1.75, 5.25, 8.75, 14.00, 21.00 and 35.00‰. Due to the scarcity of crabs, only five individuals were used at each salinity. Aquarium sea water was diluted to the required salinity with distilled water. Crabs were held for 24 h in 35.00‰ and then for a further 48 h in 28.00‰ before being placed into the appropriate test salinities. To eliminate aggressive interactions, crabs were placed singly in 200 ml plastic pottles inside 1 litre of continuously aerated sea water of the required salinity which was replaced every 48 h. Holes drilled in the pottles allowed free circulation of water. Crabs were kept in total darkness at 15°C and starved for the 8 day duration of the experiment. They were checked for survival at regular intervals and recorded as dead when there was no response to gentle probing to the eyestalk and mouthpart regions. Times to 50% mortality (LT_{50}) were determined by plotting cumulative per cent mortality against time on log-probit paper and fitting straight lines by eye (Sprague, 1969).

To investigate osmoregulation, marine ovigerous females were taken from mussels collected at Camp Bay on 19 February 1981. The same holding procedure outlined for the tolerance studies was used and 5 crabs (mean carapace width of all crabs = 10.49 mm, S.D. = 1.12 mm) were placed in each of the following salinities: 11.20, 14.50, 17.60, 20.80, 27.80 and 35.00‰. After 3 days, each crab was blotted dry with absorbant paper, and a haemolymph sample was extracted from the heart region by a fine pyrex glass pipette (crabs in 11.20‰ were sampled after 24 h as mortality in this medium was high). The osmolality (mOs/Kg{water}) of an 8 µl

sample from each individual was determined using a Wescor Vapour Pressure Osmometer (Model 5100C) measuring to a precision of ±2 mOs/Kg {water} (± S.D.).

RESULTS

Survival has been expressed as percentage survival days (Jones, 1972, 1981) (Fig.1). All crabs survived in 21.00 and 35.00‰, approximately 80% survived in 14.00‰ but in the other, more dilute salinities, survival was minimal. High survival in the upper salinity range and poor survival in the lower salinities is also evident from the LT_{50} values (Table 1). Marine ovigerous *Pinnotheres novaezelandiae* functioned as weak hyperosmotic regulators in the salinities tested (Fig.2).

TABLE 1. TIMES TO 50% MORTALITY (LT_{50}) FOR OVIGEROUS FEMALE *PINNOTHERES NOVAEZELANDIAE* COLLECTED FROM CAMP BAY (* = GREATER THAN 192 HOURS).

Salinity (‰)	LT_{50} (Hours)
35.00	*
21.00	*
14.00	*
8.75	5.6
5.25	2.9
1.75	1.8

DISCUSSION

Ovigerous female *Pinnotheres novaezelandiae* were weak regulators and exhibited a survival response intermediate between Dorgelo's (1976) Type I and II curves. These data suggest that *P. novaezelandiae* is a marine species which can only partially penetrate the estuarine environment. Low tolerance to dilute salinities and weak osmoregulatory ability indicates also that salinity may be an important factor determining the infestation rates of *Pinnotheres novaezelandiae,* particularly in reducing infestation of estuarine mussels. However, three points suggest the contrary with regard to Redcliffs, Avon-Heathcote Estuary. Firstly, salinities at Redcliffs rarely fall below approximately 21‰ (Voller, 1973) hence adult crabs at this site appear to be living within their salinity tolerance range. Secondly, as salinities below 19‰ induce valve adduction in *Perna canaliculus* (Baxter, 1981) and since regulation of the mussel mantle cavity salinity occurs well before actual shell closure (Davenport, 1979), adult *P. novaezelandiae* may never be subjected to salinities below 21‰. Finally, studies have revealed that individuals collected from habitats which experience different salinity regimes may exhibit different salinity tolerances (Anderson and Prosser, 1953; Prosser, 1955; Theede, 1975).

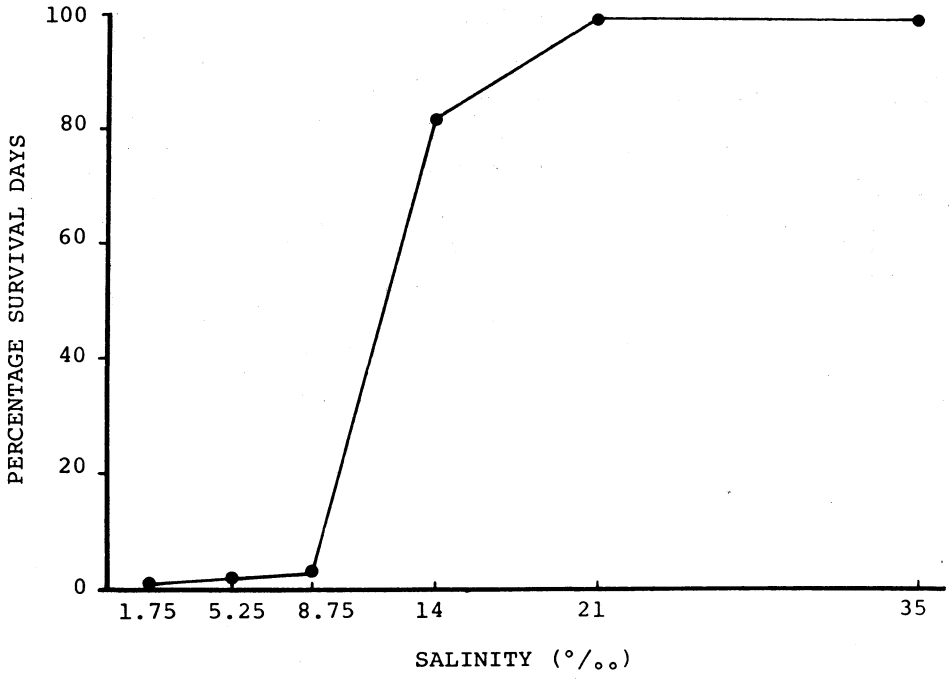

Fig. 1. Survival of marine ovigerous female *Pinnotheres novaezelandiae* at various salinities.

For example, Simons (1980), noted that *Macrophthalmus hirtipes* (Jacquinot) collected from an estuarine habitat were more efficient at regulating their haemolymph and more tolerant to salinities below 30% sea water than were individuals collected from a neighbouring marine inlet. If a similar difference occurs for *P. novaezelandiae,* then pea crabs from Redcliffs may have broader salinity tolerances than indicated in the present study. It is concluded, therefore, that salinity does not affect adult pea crab survival at Redcliffs, and that if adult survival is the primary determinant of infestation rate, then salinity has little influence on the observed infestation rate.

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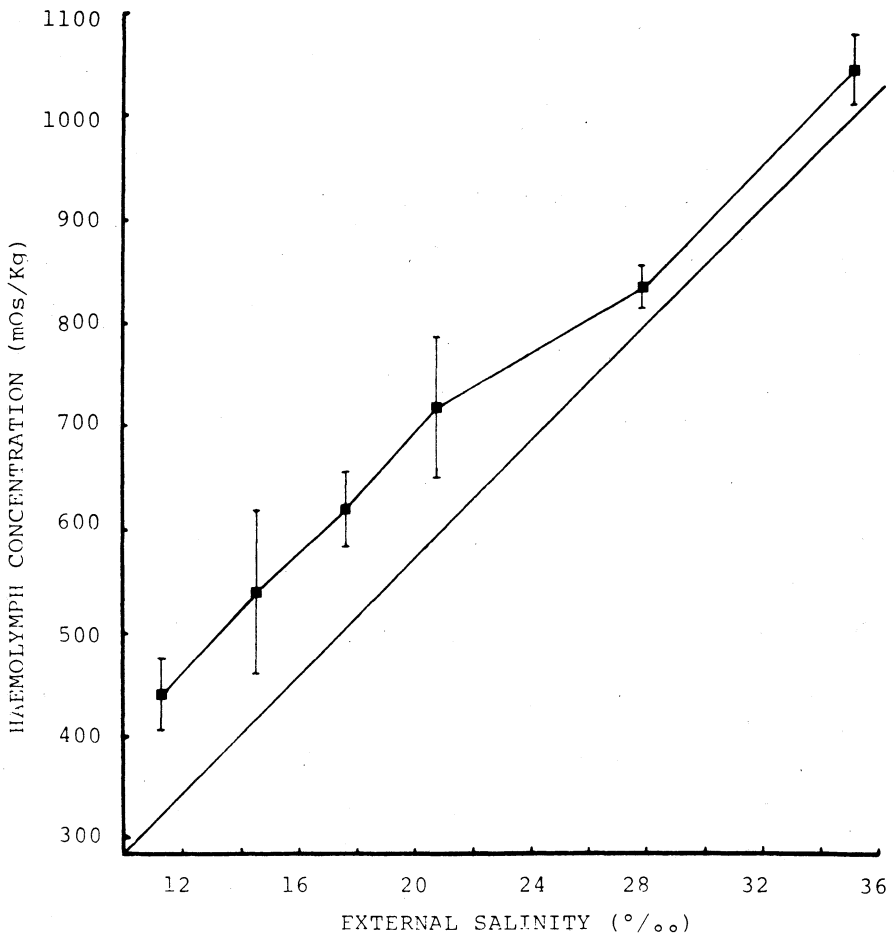

Fig. 2. Osmotic regulation of the haemolymph of marine ovigerous female *Pinnotheres novaezelandiae*. Points represent the mean of 5 replicates; vertical bars indicate 2 standard deviations.

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